Spatially Resolved Quantitative Spectroscopy of Comets

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Strategy

The objectives of my cometary research are to gain indirect knowledge of the chemical composition of cometary nuclei and the velocity field of the ejected daughter species. This can be done through conventional, high-resolution spectroscopy and indirectly by imaging the dissociation radicals in the outflowing cometary comae.

Progress and Accomplishments

Two-dimensional CCD images of Comet Austin (1989c1) were obtained with Newburn, Brown, and Dickinson using the Lick 1-m reflector on three nights in May 1990. The images were obtained using optical interference filters to isolate CN, C_2 and a good continuum wavelength. The goal of this subproject will be to continue studies of the gas production rates, comae asymmetries, and to eventually model the coma outflow mechanisms. We also obtained echellograms of comet Austin, using the conventional (multi-order) mode of the Hamilton Echelle at the Lick 3-m, and also we obtained several high spectral/spatial 2-D images using an interference filter to isolate the cometary Hα line. The circumstances for Austin placed solar-directed outflows into the sky plane with no geocentric radial velocity component.

Cometary Hα emissions arise from the photo-dissociation of H_2O and OH (plus excitation of fluorescence from the solar Ly Beta line). The velocity distribution of the H atoms near the cometary nucleus could give clues to possible heavier parent molecules. Some fraction of the H atoms are apparently thermalized to low speeds by collisions with neutral water molecules close in. Our Austin spectra show an amazingly (spatially) compact low-velocity Hα line (it is as spatially nucleated or more so than the dust component). On our one good Hα long-split echellogram of Comet Levy (1990c) we see an unusually strong blue-wing to the Hα profile. This feature, which causes a strong asymmetry on part of the cometary Hα velocity profile, is a likely jet of H gas directed from the solar-illuminated hemisphere (roughly) toward the Sun and the Earth. It does not appear to be an instrumental artifact or a likely consequence of the exciting solar LyBeta line. In this case we note, after the fact, that the geometry was favorable to detect collimated jets ejecting gas towards the Sun.

Projected Accomplishments

Analysis of the cometary CCD images (with Newburn) will continue; we also are in the midst of a detailed search of the chemical literature to help with the identification of the approximately 3,000 unidentified emission lines in our echellograms of Comets P/Brorsen-Metcalf, Austin, and Levy. The unidentified and nucleated band near λ4838 still has us baffled; it is not due to CO and probably not HCO. In any future bright comet opportunity, we also intend to measure the H_2O^+ ionic velocities in the "near-tail" with long-slit echellograms, if the geometry is suitable.